

In the Claims

Please cancel claims 1, 7 and 12 as; the limitations of claim 1 have been incorporated into amended independent claims 20 and 21; the limitations of claim 7 have been incorporated into amended independent claims 26 and 27; and the limitations of claim 12 have been incorporated into amended independent claims 32 and 33.

Please amend the claims as follows:

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2. (Amended) The method of claim 21 wherein the substrate is employed within a microelectronic fabrication selected from the group consisting of integrated circuit microelectronic fabrications, ceramic substrate microelectronic fabrications, solar cell optoelectronic microelectronic fabrications, sensor image array optoelectronic microelectronic fabrications and display image array optoelectronic microelectronic fabrications.

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3. (Amended) The method of claim 21 wherein the silicon layer is selected from the group consisting of monocrystalline silicon layers, polycrystalline silicon layers and amorphous silicon layers.

4. (Amended) The method of claim 21 wherein:
the silicon layer is masked with a mask layer, and

the mask layer is selected from the group consisting of silicon containing dielectric hard mask layers and photoresist mask layers.

5. (Amended) The method of claim 21 wherein the seasoning polymer layer is formed of a material selected from the group consisting of:

silicon and bromine containing seasoning polymer materials;
silicon, bromine and oxygen containing seasoning polymer materials;
silicon and chlorine containing seasoning polymer materials;
silicon, chlorine and oxygen containing seasoning polymer materials;
silicon, bromine and chlorine containing seasoning polymer materials; and
silicon, bromine, chlorine and oxygen containing seasoning polymer materials.

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8. (Amended) The method of claim 27 wherein the substrate is employed within a microelectronic fabrication selected from the group consisting of integrated circuit microelectronic fabrications, ceramic substrate microelectronic fabrications, solar cell optoelectronic microelectronic fabrications, sensor image array optoelectronic microelectronic fabrications and display image array optoelectronic microelectronic fabrications.

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9. (Amended) The method of claim 27 wherein:

the first monocrystalline silicon layer is masked with a mask layer; and
the mask layer is selected from the group consisting of silicon containing dielectric hard mask layers and photoresist mask layers.

10. (Amended) The method of claim 27 wherein the seasoning polymer layer is formed of a material selected from the group consisting of:

silicon and bromine containing seasoning polymer materials;

silicon, bromine and oxygen containing seasoning polymer materials;

silicon and chlorine containing seasoning polymer materials;

silicon, chlorine and oxygen containing seasoning polymer materials;

silicon, bromine and chlorine containing seasoning polymer materials; and

silicon, bromine, chlorine and oxygen containing seasoning polymer materials.

13. (Amended) The method of claim 33 wherein the substrate is employed within a microelectronic fabrication selected from the group consisting of integrated circuit microelectronic fabrications, ceramic substrate microelectronic fabrications, solar cell optoelectronic microelectronic fabrications, sensor image array optoelectronic microelectronic fabrications and display image array optoelectronic microelectronic fabrications.

14. (Amended) The method of claim 33 wherein:

the polycrystalline silicon layer is masked with a mask layer; and

the mask layer is selected from the group consisting of silicon containing dielectric hard mask layers and photoresist mask layers.

15. (Amended) The method of claim 33 wherein the seasoning polymer layer is formed of a material selected from the group consisting of:

- silicon and bromine containing seasoning polymer materials;
- silicon, bromine and oxygen containing seasoning polymer materials;
- silicon and chlorine containing seasoning polymer materials;
- silicon, chlorine and oxygen containing seasoning polymer materials;
- silicon, bromine and chlorine containing seasoning polymer materials; and
- silicon, bromine, chlorine and oxygen containing seasoning polymer materials.

17. (Amended) The method of claim 21, wherein the dummy wafer seasoning methods include a method selected from the group consisting of:

- i) a silicon oxide coated dummy wafer method;
- ii) a silicon oxide coated dummy wafer method in conjunction with the seasoning plasma etch method additionally employing an oxygen containing etchant gas; and
- iii) a silicon dummy wafer method in conjunction with the seasoning plasma etch method additionally employing an oxygen containing etchant gas.

18. (Amended) The method of claim 21, wherein the dummy wafer seasoning methods, when using an eight inch diameter substrate, employ:

- a plasma reactor chamber pressure of from about 1 to 500 mTorr;
- a source radio frequency power of from about 10 to 2000 watts at a source radio frequency of from about 2 to 13.56 MHz;

a plasma reactor chamber temperature and a dummy wafer temperature of from about 20 to 200°C;

a bromine and/or chlorine containing etchant gas flow rate of from about 10 to 200 sccm;

an optional oxygen containing etchant gas flow rate of from about 1 to 50 sccm;

a backside cooling gas pressure of from about 1 to 50 torr and a flow rate of from about 2 to 50 sccm;

a magnetic field of up to about 200 gauss; and

a plasma seasoning time of from about 5 to 120 seconds.

19. (Amended) The method of claim 21, wherein the product wafer in-situ seasoning methods, when using an eight inch diameter substrate, employ:

a plasma reactor chamber pressure of from about 50 to 1000 mTorr;

a source radio frequency power of from about 10 to 1000 watts at a source radio frequency of from about 2 to 13.56 MHz;

a plasma reactor chamber temperature and a product substrate temperature of from about 20 to 200°C;

a silicon containing seasoning polymer layer forming gas flow rate of from about 1 to 200 sccm;

a bromine and/or chlorine containing etchant gas flow rate of from about 10 to 200 sccm;

an optional oxygen containing etchant gas flow rate of from about 1 to 50 sccm;

a backside cooling gas pressure of from about 1 to 50 torr and a flow rate of from about 2 to 50 sccm;

a magnetic field of up to about 200 gauss; and

a plasma seasoning time of from about 5 to 120 seconds.

20. (Amended) A method for forming an etched silicon layer comprising:

providing a first substrate having formed thereover a first silicon layer;

etching the first silicon layer to form an etched first silicon layer while employing a plasma etch method employing a plasma reactor chamber in conjunction with a plasma etchant gas composition which upon plasma activation provides at least one of an active bromine containing etchant species and an active chlorine containing etchant species, wherein within the plasma etch method:

(1) a cleaned plasma reactor chamber is seasoned to provide a seasoned plasma reactor chamber having a seasoning polymer layer formed therein; wherein the seasoning method is selected from the group consisting of dummy wafer seasoning methods, product wafer in-situ seasoning methods and waferless seasoning methods; wherein the waferless seasoning methods employ:

a plasma reactor chamber pressure of from about 50 to 1000 mTorr;

a source radio frequency power of from about 10 to 1000 watts at a source

radio frequency of from about 2 to 13.56 MHz;

a plasma reactor chamber temperature of from about 20 to 200°C;

a silicon containing seasoning polymer layer forming gas flow rate of from about 1 to 200 sccm;

a bromine and/or chlorine containing etchant gas flow rate of from about 10
20 to 200 sccm;

an optional oxygen containing etchant gas flow rate of from about 1 to 50
sccm;

a magnetic field of up to about 200 gauss; and

a plasma seasoning time of from about 5 to 120 seconds;

25 (2) the first silicon layer is etched to form the etched first silicon layer
within the seasoned plasma reactor chamber; and

(3) the seasoning polymer layer is cleaned from the seasoned plasma
reactor chamber to provide the cleaned plasma reactor chamber after etching the first
silicon layer to form the etched first silicon layer within the seasoned plasma reactor
30 chamber prior to etching a second substrate having formed thereover a second
silicon layer to form an etched second silicon layer formed over the second substrate
within the plasma reactor chamber while employing the plasma etch method in
accord with (1), (2) and (3).

21. (Amended) A method for forming an etched silicon layer comprising:

providing a first substrate having formed thereover a first silicon layer;

9217 etching the first silicon layer to form an etched first silicon layer while
employing a plasma etch method employing a plasma reactor chamber in
5 conjunction with a plasma etchant gas composition which upon plasma activation
provides at least one of an active bromine containing etchant species and an active
chlorine containing etchant species, wherein within the plasma etch method:

(1) a cleaned plasma reactor chamber is seasoned to provide a seasoned plasma reactor chamber having a seasoning polymer layer formed therein; wherein
10 the seasoning method is selected from the group consisting of dummy wafer seasoning methods, product wafer in-situ seasoning methods and waferless seasoning methods;

(2) the first silicon layer is etched to form the etched first silicon layer within the seasoned plasma reactor chamber; wherein the first silicon layer etch step, when using an eight inch diameter substrate, employs:

a reactor chamber pressure of from about 1 to 500 mTorr;

a radio frequency source power of from about 10 to 2000 watts at a source radio frequency of from about 2 to 13.56 MHz and an external bias power of up to about 500 watts;

20 a substrate temperature and a seasoned plasma reactor chamber temperature of from about 20 to 200°C;

a hydrogen bromide flow rate of from about 10 to 200 sccm;

an oxygen flow rate of from about 1 to 50 sccm;

a nitrogen trifluoride flow rate of from about 1 to 50 sccm;

25 a backside cooling gas pressure of from about 1 to 50 torr and a flow rate of from about 2 to 50 sccm; and

a magnetic field of up to about 200 gauss; and

(3) the seasoning polymer layer is cleaned from the seasoned plasma reactor chamber to provide the cleaned plasma reactor chamber after etching the first
30 silicon layer to form the etched first silicon layer within the seasoned plasma reactor chamber prior to etching a second substrate having formed thereover a second

silicon layer to form an etched second silicon layer formed over the second substrate within the plasma reactor chamber while employing the plasma etch method in accord with (1), (2) and (3). *RE*

22. (Amended) The method of claim 21, wherein the seasoned plasma reactor chamber cleaning step, when using an eight inch diameter substrate, employs:

a seasoned plasma reactor chamber pressure of from about 50 to 500mTorr;

a source radio frequency power of from about 100 to 200 watts at a source

radio frequency of from about 2 to 13.56 MHz and a bias power of up to about 500 watts;

a seasoned plasma reactor chamber temperature of from about 20 to 200°C;

a nitrogen trifluoride or a sulfur hexafluoride flow rate of from about 10 to 500 sccm;

a backside cooling gas pressure of from about 1 to 50 torr and a flow rate of from about 2 to 50 sccm; and

a magnetic field of up to about 200 gauss.

23. (Amended) The method of claim 27, wherein the dummy wafer seasoning methods include a method selected from the group consisting of:

i) a silicon oxide coated dummy wafer method;

ii) a silicon oxide coated dummy wafer method in conjunction with the seasoning plasma etch method additionally employing an oxygen containing etchant gas; and

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iii) a silicon dummy wafer method in conjunction with the seasoning plasma etch method additionally employing an oxygen containing etchant gas.

24. The method of claim 27, wherein the dummy wafer seasoning methods, when using an eight inch diameter substrate, employ:

a plasma reactor chamber pressure of from about 1 to 500 mTorr;

a source radio frequency power of from about 10 to 2000 watts at a source radio frequency of from about 2 to 13.56 MHz;

a plasma reactor chamber temperature and a dummy wafer temperature of from about 20 to 200°C;

a bromine and/or chlorine containing etchant gas flow rate of from about 10 to 200 sccm;

an optional oxygen containing etchant gas flow rate of from about 1 to 50 sccm;

a backside cooling gas pressure of from about 1 to 50 torr and a flow rate of from about 2 to 50 sccm;

a magnetic field of up to about 200 gauss; and

a plasma seasoning time of from about 5 to 120 seconds.

25. The method of claim 27, wherein the product wafer in-situ seasoning methods, when using an eight inch diameter substrate, employ:

a plasma reactor chamber pressure of from about 50 to 1000 mTorr;

a source radio frequency power of from about 10 to 1000 watts at a source radio frequency of from about 2 to 13.56 MHz;

a plasma reactor chamber temperature and a product substrate temperature of from about 20 to 200°C;

a silicon containing seasoning polymer layer forming gas flow rate of from about 1 to 200 sccm;

a bromine and/or chlorine containing etchant gas flow rate of from about 10 to 200 sccm;

an optional oxygen containing etchant gas flow rate of from about 1 to 50 sccm;

a backside cooling gas pressure of from about 1 to 50 torr and a flow rate of from about 2 to 50 sccm;

a magnetic field of up to about 200 gauss; and

a plasma seasoning time of from about 5 to 120 seconds.

26. (Amended) A method for forming an etched monocrystalline silicon layer comprising:

BS providing a first substrate having formed thereover a first monocrystalline silicon layer;

5 etching the first monocrystalline silicon layer to form an etched first monocrystalline silicon layer while employing a plasma etch method employing a plasma reactor chamber in conjunction with a plasma etchant gas composition which upon plasma activation provides at least one of an active bromine containing etchant species and an active chlorine containing etchant species, wherein within the plasma
10 etch method:

(1) a cleaned plasma reactor chamber is seasoned to provide a seasoned plasma reactor chamber having a seasoning polymer layer formed therein; wherein the seasoning method is selected from the group consisting of dummy wafer seasoning methods, product wafer in-situ seasoning methods and waferless

15 seasoning methods; wherein the waferless seasoning methods employ:

a plasma reactor chamber pressure of from about 50 to 1000 mTorr;

a source radio frequency power of from about 10 to 1000 watts at a source radio frequency of from about 2 to 13.56 MHz;

a plasma reactor chamber temperature of from about 20 to 200°C;

20 a silicon containing seasoning polymer layer forming gas flow rate of from about 1 to 200 sccm;

a bromine and/or chlorine containing etchant gas flow rate of from about 10 to 200 sccm;

25 an optional oxygen containing etchant gas flow rate of from about 1 to 50 sccm;

a magnetic field of up to about 200 gauss; and

a plasma seasoning time of from about 5 to 120 seconds ;

(2) the first monocrystalline silicon layer is etched to form the etched first monocrystalline silicon layer within the seasoned plasma reactor chamber; and

30 (3) the seasoning polymer layer is cleaned from the seasoned plasma reactor chamber to provide the cleaned plasma reactor chamber after etching the first monocrystalline silicon layer to form the etched first monocrystalline silicon layer within the seasoned plasma reactor chamber prior to etching a second substrate having formed thereover a second monocrystalline silicon layer to form an etched

35 second monocrystalline silicon layer formed over the second substrate within the plasma reactor chamber while employing the plasma etch method in accord with (1), (2) and (3).

27. (Amended) A method for forming an etched monocrystalline silicon layer comprising:

providing a first substrate having formed thereover a first monocrystalline silicon layer;

etching the first monocrystalline silicon layer to form an etched first monocrystalline silicon layer while employing a plasma etch method employing a plasma reactor chamber in conjunction with a plasma etchant gas composition which upon plasma activation provides at least one of an active bromine containing etchant species and an active chlorine containing etchant species, wherein within the plasma etch method:

(1) a cleaned plasma reactor chamber is seasoned to provide a seasoned plasma reactor chamber having a seasoning polymer layer formed therein; wherein the seasoning method is selected from the group consisting of dummy wafer seasoning methods, product wafer in-situ seasoning methods and waferless seasoning methods;

(2) the first monocrystalline silicon layer is etched to form the etched first monocrystalline silicon layer within the seasoned plasma reactor chamber; wherein the first monocrystalline silicon layer etch step, when using an eight inch diameter substrate, employs:

a reactor chamber pressure of from about 1 to 500 mTorr;

a radio frequency source power of from about 10 to 2000 watts at a source radio frequency of from about 2 to 13.56 MHz and an external bias power of up to about 500 watts;

a substrate temperature and a seasoned plasma reactor chamber temperature of from about 20 to 200°C;

a hydrogen bromide flow rate of from about 10 to 200 sccm;

an oxygen flow rate of from about 1 to 50 sccm;

a nitrogen trifluoride flow rate of from about 1 to 50 sccm;

a backside cooling gas pressure of from about 1 to 50 torr and a flow rate of from about 2 to 50 sccm; and

a magnetic field of up to about 200 gauss; and

(3) the seasoning polymer layer is cleaned from the seasoned plasma reactor chamber to provide the cleaned plasma reactor chamber after etching the first monocrystalline silicon layer to form the etched first monocrystalline silicon layer within the seasoned plasma reactor chamber prior to etching a second substrate having formed thereover a second monocrystalline silicon layer to form an etched second monocrystalline silicon layer formed over the second substrate within the plasma reactor chamber while employing the plasma etch method in accord with (1), (2) and (3).

28. The method of claim 27, wherein the seasoned plasma reactor chamber cleaning step, when using an eight inch diameter substrate, employs:

a seasoned plasma reactor chamber pressure of from about 50 to 500mTorr;

a source radio frequency power of from about 100 to 200 watts at a source radio frequency of from about 2 to 13.56 MHz and a bias power of up to about 500 watts;

a seasoned plasma reactor chamber temperature of from about 20 to 200°C;

a nitrogen trifluoride or a sulfur hexafluoride flow rate of from about 10 to 500 sccm;

a backside cooling gas pressure of from about 1 to 50 torr and a flow rate of from about 2 to 50 sccm; and

a magnetic field of up to about 200 gauss.

29. The method of claim 33, wherein the dummy wafer seasoning methods include a method selected from the group consisting of:

i) a silicon oxide coated dummy wafer method;

ii) a silicon oxide coated dummy wafer method in conjunction with the seasoning plasma etch method additionally employing an oxygen containing etchant gas; and

iii) a silicon dummy wafer method in conjunction with the seasoning plasma etch method additionally employing an oxygen containing etchant gas.

30. The method of claim 33, wherein the dummy wafer seasoning methods, when using an eight inch diameter substrate, employ:

a plasma reactor chamber pressure of from about 1 to 500 mTorr;

a source radio frequency power of from about 10 to 2000 watts at a source radio frequency of from about 2 to 13.56 MHz;

a plasma reactor chamber temperature and a dummy wafer temperature of from about 20 to 200°C;

a bromine and/or chlorine containing etchant gas flow rate of from about 10 to 200 sccm;

an optional oxygen containing etchant gas flow rate of from about 1 to 50 sccm;

a backside cooling gas pressure of from about 1 to 50 torr and a flow rate of from about 2 to 50 sccm;

a magnetic field of up to about 200 gauss; and

a plasma seasoning time of from about 5 to 120 seconds.

31. The method of claim 33, wherein the product wafer in-situ seasoning methods, when using an eight inch diameter substrate, employ:

a plasma reactor chamber pressure of from about 50 to 1000 mTorr;

a source radio frequency power of from about 10 to 1000 watts at a source radio frequency of from about 2 to 13.56 MHz;

a plasma reactor chamber temperature and a product substrate temperature of from about 20 to 200°C;

a silicon containing seasoning polymer layer forming gas flow rate of from about 1 to 200 sccm;

a bromine and/or chlorine containing etchant gas flow rate of from about 10 to 200 sccm;

an optional oxygen containing etchant gas flow rate of from about 1 to 50 sccm;

a backside cooling gas pressure of from about 1 to 50 torr and a flow rate of from about 2 to 50 sccm;

a magnetic field of up to about 200 gauss; and

a plasma seasoning time of from about 5 to 120 seconds.

32. (Amended) A method for forming an etched polycrystalline silicon layer comprising:

providing a first substrate having formed thereover a first polycrystalline silicon layer;

5 etching the first polycrystalline silicon layer to form an etched first polycrystalline silicon layer while employing a plasma etch method employing a plasma reactor chamber in conjunction with a plasma etchant gas composition which upon plasma activation provides an active bromine containing etchant species, wherein within the plasma etch method:

10 (1) a cleaned plasma reactor chamber is seasoned to provide a seasoned plasma reactor chamber having a seasoning polymer layer formed therein; wherein the seasoning method is selected from the group consisting of dummy wafer seasoning methods, product wafer in-situ seasoning methods and waferless seasoning methods; wherein the waferless seasoning methods employ:

15 a plasma reactor chamber pressure of from about 50 to 1000 mTorr;
 a source radio frequency power of from about 10 to 1000 watts at a source radio frequency of from about 2 to 13.56 MHz;
 a plasma reactor chamber temperature of from about 20 to 200°C;

- a silicon containing seasoning polymer layer forming gas flow rate of from
20 about 1 to 200 sccm;
a bromine and/or chlorine containing etchant gas flow rate of from about 10
to 200 sccm;
an optional oxygen containing etchant gas flow rate of from about 1 to 50
sccm;
25 a magnetic field of up to about 200 gauss; and
a plasma seasoning time of from about 5 to 120 seconds;
(2) the first polycrystalline silicon layer is etched to form the etched first
polycrystalline silicon layer within the seasoned plasma reactor chamber; and
(3) the seasoning polymer layer is cleaned from the seasoned plasma
30 reactor chamber to provide the cleaned plasma reactor chamber after etching the first
polycrystalline silicon layer to form the etched first polycrystalline silicon layer
within the seasoned plasma reactor chamber prior to etching a second substrate
having formed thereover a second polycrystalline silicon layer to form an etched
second polycrystalline silicon layer formed over the second substrate within the
35 plasma reactor chamber while employing the plasma etch method in accord with (1),
(2) and (3).

33. (Amended) A method for forming an etched polycrystalline silicon layer
comprising:

providing a first substrate having formed thereover a first polycrystalline
silicon layer;

5 etching the first polycrystalline silicon layer to form an etched first
polycrystalline silicon layer while employing a plasma etch method employing a
plasma reactor chamber in conjunction with a plasma etchant gas composition which
upon plasma activation provides an active bromine containing etchant species,
wherein within the plasma etch method:

10 (1) a cleaned plasma reactor chamber is seasoned to provide a seasoned
plasma reactor chamber having a seasoning polymer layer formed therein; wherein
the seasoning method is selected from the group consisting of dummy wafer
seasoning methods, product wafer in-situ seasoning methods and waferless
seasoning methods;

15 (2) the first polycrystalline silicon layer is etched to form the etched first
polycrystalline silicon layer within the seasoned plasma reactor chamber; wherein
the first polycrystalline silicon layer etch step, when using an eight inch diameter
substrate, employs:

a reactor chamber pressure of from about 1 to 500 mTorr;

20 a radio frequency source power of from about 10 to 2000 watts at a source
radio frequency of from about 2 to 13.56 MHz and an external bias power of up to
about 500 watts;

a substrate temperature and a seasoned plasma reactor chamber temperature
of from about 20 to 200°C;

25 a hydrogen bromide flow rate of from about 10 to 200 sccm;

an oxygen flow rate of from about 1 to 50 sccm;

a nitrogen trifluoride flow rate of from about 1 to 50 sccm;

a backside cooling gas pressure of from about 1 to 50 torr and a flow rate of from about 2 to 50 sccm; and

30 a magnetic field of up to about 200 gauss; and

(3) the seasoning polymer layer is cleaned from the seasoned plasma reactor chamber to provide the cleaned plasma reactor chamber after etching the first polycrystalline silicon layer to form the etched first polycrystalline silicon layer within the seasoned plasma reactor chamber prior to etching a second substrate having formed thereover a second polycrystalline silicon layer to form an etched second polycrystalline silicon layer formed over the second substrate within the plasma reactor chamber while employing the plasma etch method in accord with (1), (2) and (3).

34. The method of claim 33, wherein the seasoned plasma reactor chamber cleaning step, when using an eight inch diameter substrate, employs:

a seasoned plasma reactor chamber pressure of from about 50 to 500mTorr;
a source radio frequency power of from about 100 to 200 watts at a source radio frequency of from about 2 to 13.56 MHz and a bias power of up to about 500 watts;

a seasoned plasma reactor chamber temperature of from about 20 to 200°C;
a nitrogen trifluoride or a sulfur hexafluoride flow rate of from about 10 to 500 sccm;

a backside cooling gas pressure of from about 1 to 50 torr and a flow rate of from about 2 to 50 sccm; and

a magnetic field of up to about 200 gauss.